

Estimating the Date of Earth Overshoot Day 2021

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Overview: Earth Overshoot Day Calculation

Earth Overshoot Day is the day of the year on which humanity's demand on nature exceeds the Earth's annual biological capacity to regenerate.

In 2021, Earth Overshoot Day falls on July 29th, meaning that between January 1st and July 29th, humanity's demand for biological regeneration is equivalent to the planet's entire annual regeneration. In 2020, Earth Overshoot Day fell on August 22nd.

The Need for Nowcasting

The [National Footprint and Biocapacity Accounts](#) (NFA) are built on official UN datasets. But this data come with a time delay. Typically, the latest data is delayed by about 4 years, meaning that the 2021 edition of the National Footprint and Biocapacity Accounts reports results up to 2017.

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Since Earth Overshoot Day is based on the current year's consumption, nowcasting is needed to provide an estimate of where humanity's demand stands compared to the planet's biocapacity in 2021. For this reason, Global Footprint Network offers nowcasting, which is distinct from forecasting. Forecasting uses models to extrapolate data into the future, based on assumptions of how the forecasted item operates. Nowcasting uses actual data, but that data may be spottier, from less official sources, or provide only proxy information. For instance, more recent trend data on aspects of the NFA, such as car usage, electricity intensity, and change in housing stock, can show relative changes of those aspects, and may be superimposed over the more complete NFAs that end 4 years prior.

This is not that different from economic indicators like GDP, which are reported in a timely fashion, sometimes even by quarter. More timely estimates are needed as well because most democratically elected governments have had elections within the last four years. So, although Ecological Footprint and biocapacity does not shift rapidly and historical trends are informative, 4-year-old data may seem outdated for governments in power – they do not reflect their impact on the trajectory of their resource consumption.

Methodological Overview: Accounting for Biocapacity

The Ecological Footprint's underlying research question is straightforward: How much mutually exclusive, biologically productive area¹ is necessary to renew people's demand for nature's products and services? The demands on nature that compete for biocapacity include:

- food, fibre, timber,
- space for roads and structures,
- energy production (from hydropower to biomass),
- waste absorption, incl. CO₂ from fossil fuel or cement production.

Both biocapacity and Ecological Footprint can be tracked and compared against each other, based on two simple principles:

¹ Before adding up the areas, they are first productivity adjusted, hence measured in global hectares. This makes biocapacity and Footprints comparable across time and space, since the areas are weighed proportionally to their biocapacity.

- (1) **Commensurability:** by scaling these areas proportional to their biological productivity, they become commensurable.
- (2) **Additionality:** all the competing demands on productive surfaces, i.e., the surfaces that contain the planet's biocapacity, can be added up.

The measurement unit used is “global hectare,” which is a biologically productive hectare with world-average productivity. More details about the principles and mechanics of this accounting system are documented extensively in [this literature](#) and on Global Footprint Network's [website](#). An overview of the principles is available in open-access papers in [Sustainability](#) and in [Nature Sustainability](#), as well as the [supplementary information](#) of the latter.

Calculations for countries and the world as a whole are done through the National Footprint and Biocapacity Accounts, based on 15,000 data points per country per year.

Starting Point: National Footprint and Biocapacity Accounts

Nowcasting is an extension of the [National Footprint and Biocapacity Accounts](#), including the latest results (2017) and time series (1961-2017). These accounts are comprehensive biophysical balance sheets that compare countries' demand on nature with what the planet or that country's ecosystems can renew. They build on the premise that materially, the most limiting factor for the human economy is our planet's ecosystems' capacity (its “biocapacity”). They inform us about every country's unique sustainability challenges, including climate change and resource constraints.

Recognizing the overarching biological constraints to human metabolisms, these accounts focus on tracking humanity's or a country's material demands (Footprint, red line in figure below).

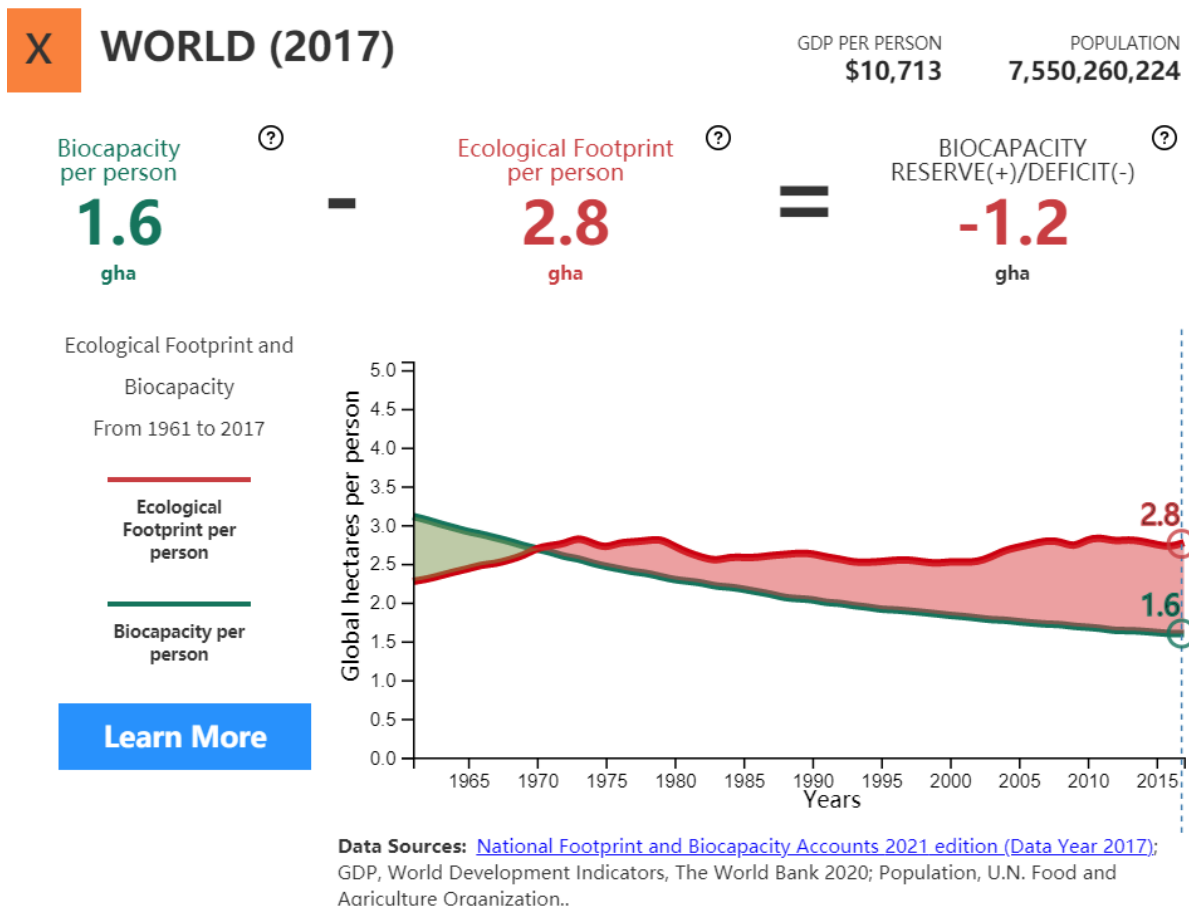


Figure 1 – Humanity’s Ecological Footprint and the planet’s biocapacity in global hectares per person from 1961 to 2017 (2021 edition). data.footprintnetwork.org

That demand is contrasted with how much biologically productive area is available within the world (or also within a country, when countries are analyzed (biocapacity, green line in figure above)). Figure 1 shows the per person results of the National Footprint and Biocapacity Accounts for the world. The same results can also be depicted as [absolute](#), i.e. the total Ecological Footprint and total biocapacity of the world. The ratio between Footprint and biocapacity shown is the same for both perspectives.

While Footprint and biocapacity assessments are possible at any scale, the NFAs are a useful reference point as they are based on data from UN statistics, rather than data that has been chosen arbitrarily. They are also based on clear accounting principles.²

² National Footprint and Biocapacity Accounts are the reference point for all other Footprint analyses at other scales, down to the product level. Footprint standards (www.footprintstandards.org) provide guidance on how to make assessments at any scale consistent.

The accounts have been published and improved upon annually since 1997. They have also been [tested by over ten national government agencies](#). The mechanics of the accounts and the results they produce have been confirmed. For instance, both the French and the Swiss government reviews reproduced the results within 3%. (Some agencies did not like the implications of the results, but no agency has proven them to be inaccurate.)

Our priority is to make the accounts more trusted and neutral. Thus, we have established a new organization with external partners to serve this very purpose. This new home for the National Footprint and Biocapacity Accounts is the “Footprint Data Foundation” (www.FoDaFo.org), initiated by [York University](#) and Global Footprint Network. Its sole purpose is to maintain and improve the accounts. The [new institutional](#) arrangement for producing the accounts is governed through an independent board to secure neutrality and scientific rigor.

Results of the National Footprint and Biocapacity Accounts are available on the open data platform at data.footprintnetwork.org, as well as through a downloadable spreadsheet workbook ([public data package](#)). The 2021 edition, which is the latest edition, was released in November 2020. Its results stretch to 2017.

Nowcasting: Extending the Trends of the National Footprint and Biocapacity Accounts

To determine Earth Overshoot Day, we calculate the ratio between Earth’s biocapacity and its Ecological Footprint. Ecological Footprint and biocapacity results are extended beyond 2017, the year or the latest reported results, through nowcasting. Nowcasting is a statistical forecasting method that incorporates data from recent trend reports and studies.

Nowcast results for the world: 2021

For Earth Overshoot Day 2021, the total Ecological Footprint increased by 4.6% compared to the previous year, while total biocapacity increased by 0.3% over the same time span.

The carbon Footprint calculation nowcast was based on CO₂ emissions data from International Energy Agency (IEA) and ocean carbon sequestration data from the Global Carbon Project (GCP). As reported by IEA, the global pandemic induced lockdowns caused an initial sharp drop on CO₂ emissions. But they increased again in the second half of the year. At the end of the year, total emissions were reported to be 5.8% lower than 2019 emissions due to the global pandemic. In 2021, emissions are estimated to increase by 4.8% compared to 2020, leaving us just below 2019 emissions levels. Combined with the most recent data from GCP, the carbon Footprint appears to increase by 6.6% in 2021 compared to the year prior.

The second reported change incorporated into the nowcast was the effect of Amazon deforestation and degradation on global forest biocapacity. In 2021, deforestation in the Amazon spiked, and was estimated to increase by 43%³ from 2020, when 1.1 million hectares⁴ were destroyed. Additionally, carbon loss in the Amazon forest due to degraded lands was estimated to be 3 times⁵ the amount lost via deforestation. Non-Amazon forests were conservatively assumed to follow the existing biocapacity trajectory. The resulting loss of global forest biocapacity was estimated to be 0.5%.

For all external data, we assume that reported changes to the previous year hold constant throughout 2021.

Figure 2 below shows the nowcasting results for the world. We will have more detailed results to verify our nowcast using UN data in the 2025 edition of the National Footprint and Biocapacity Accounts.

The nowcast produced the following estimates: The biocapacity for the world in 2021 is estimated at 1.5 global hectares per person. In contrast, humanity's Ecological Footprint is 2.7 global hectares per person, of which 61% is carbon Footprint.

³ <https://www.reuters.com/business/environment/deforestation-brazils-amazon-rainforest-rises-second-straight-month-2021-05-07/>

⁴ <https://www.nature.com/articles/s41559-020-01368-x>

⁵ <https://www.nature.com/articles/s41558-021-01026-5>

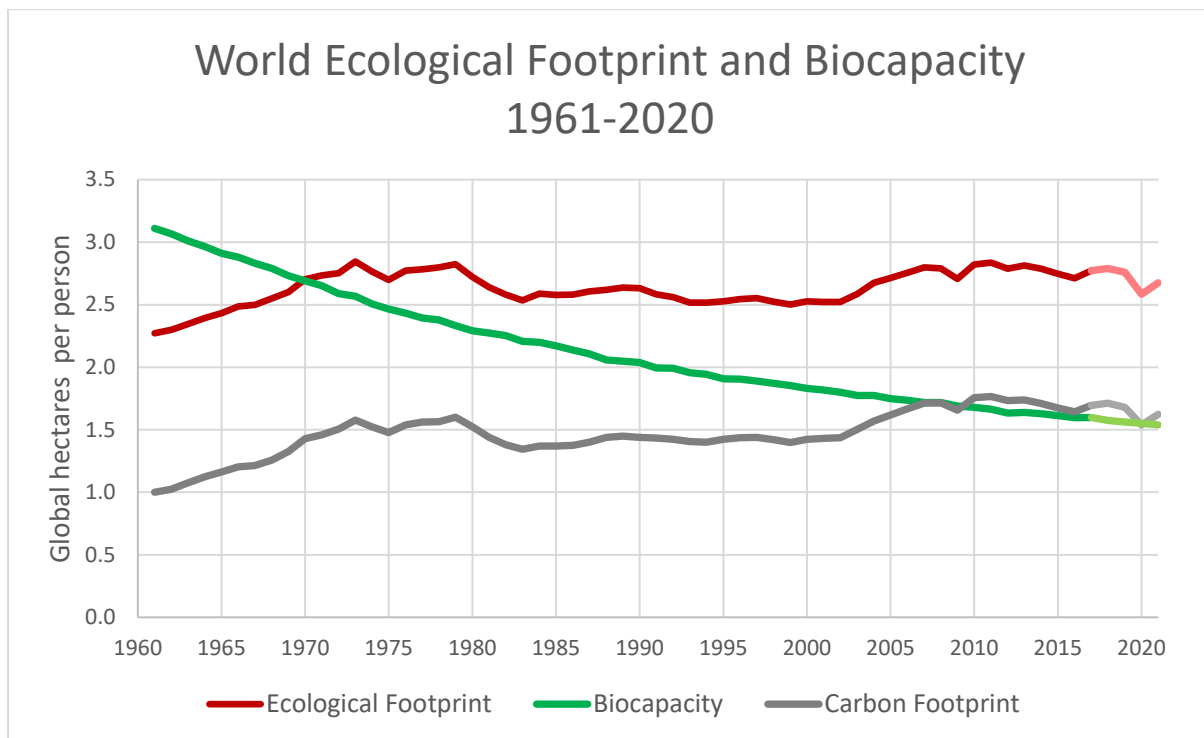


Figure 2 – The global per person Ecological Footprint and biocapacity from 1960 to 2021 in global hectares per person. The red line is the total Ecological Footprint per person, and the grey line is the Carbon Footprint per person (a subset of the Ecological Footprint). The green line shows the biocapacity per person. Results for 2018-2021 are nowcast estimates; remaining data points are directly taken from the National Footprint and Biocapacity Accounts, 2021 edition.

Note that in 2020, the Ecological Footprint was significantly reduced in the early part of the year, [most significantly in Q2](#). But in Q3 and Q4, even though the lockdowns persisted, consumption seemed to increase again, reversing some of the reduction. These transitional effects during the year are not shown in this assessment since it averages demand and regeneration on an annual basis.⁶ This also compensates for natural fluctuations in consumption and regeneration across the year. Still, overall, the per person carbon Footprint declined in 2020 compared to 2019.

⁶ Estimating Earth Overshoot Day based on annual consumption implicitly assumes a constant rate of resource use across the year. However in 2020, because of COVID, the demand reduction was overproportional in Q2. Since Earth Overshoot Day is assessed based on amount used between January 1 and that day, delayed resource use in the year would move out the Earth Overshoot Day, compared to a calculation based on the annual average. To illustrate a similar example: Assume we have a salary of \$75 per year, but spend \$100 over the course of that year. If we spend the same amount equally across the year, we'd be through the money by the end of September: $\$75/\$100 = 75\% = 9$ months. However, if we don't spend at a constant rate, the actual day of overshoot can vary. If we spend \$50 in January, and then wait with spending the other \$50 until December, then the actual day we overspend our budget will be in mid-December of that year.

Relevant publicly available references

- Video introduction to the National Footprint and Biocapacity Accounts, including its underlying method: [www.youtube.com/watch?v= T5M3MiPFW4](https://www.youtube.com/watch?v=T5M3MiPFW4) (2.5 min)
- Ecological Footprint Results for countries: data.footprintnetwork.org
- The basics on the accounting method, including a [guidebook](#) on the National Footprint and Biocapacity Accounts and a detailed [paper on the calculation method](#) are provided here: www.footprintnetwork.org/resources/data/
- Accounting Method and recent improvements in the accounting method: www.mdpi.com/2079-9276/7/3/58 (*Ecological Footprint Accounting for Countries: Updates and Results of the National Footprint Accounts, 2012–2018*)
- A free click-through license gives you access to a sample workbook (for Hungary 2014) www.footprintnetwork.org/licenses/workbook-learning-license
- A comprehensive workbook with the newest Ecological Footprint and biocapacity contains key results www.footprintnetwork.org/licenses/public-data-package-free
- Limitations and Criticisms: The Ecological Footprint has clear limitations. And criticism drives the scientific process. All sincere criticism is helpful, whether based on misunderstandings, new insights, or flaws in the methodology. Global Footprint Network summarized www.footprintnetwork.org/our-work/ecological-footprint/limitations-and-criticisms/
- Nowcasting the global Ecological Footprint for Earth Overshoot 2020: www.overshootday.org/2020-calculation
- Rationale and interpretation of country level results: www.mdpi.com/2071-1050/11/7/2164/htm (*Defying the Footprint Oracle: Implications of Country Resource Trends*); Section 2 discusses key premises, comparison Footprint to other metrics
- EU [fact sheet on the Ecological Footprint](#) and results for European countries on the [EEA website](#)
- Biodiversity and other Ecological Footprint applications: <https://www.bipindicators.net/indicators/ecological-footprint/>; <https://doi.org/10.1016/j.biocon.2013.10.019> (Ecological Footprint: Implications for biodiversity)
- The new platform for National Footprint and Biocapacity Accounts: www.FoDaFo.org; footprint.info.yorku.ca; www.OnePlanetAlliance.org
- Short video from 2005 explaining the Footprint concepts in 3 min (it is a bit dated, but still provides an accurate description) www.youtube.com/watch?v=EjyrAHzthTo. A more general introduction is provided in the new book [Ecological Footprint: Managing our Biocapacity Budget](#)
- EEA updated the Ecological Footprint results last in 2020 (based on a report Global Footprint Network produced for them) <https://www.eea.europa.eu/data-and-maps/indicators/ecological-footprint-of-european-countries-2/assessment>
- The EC's [Beyond GDP website](#) recently updated the description of Ecological Footprint accounting [here](#)